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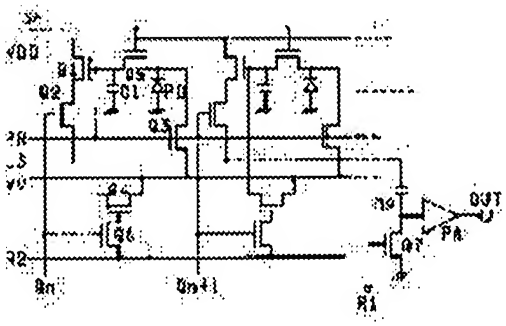
(54) SOLID-STATE IMAGE PICKUP ELEMENT

(57)Abstract:

PURPOSE: To provide a solid-state image pickup element with low power consumption and provided with an electronic shutter function.

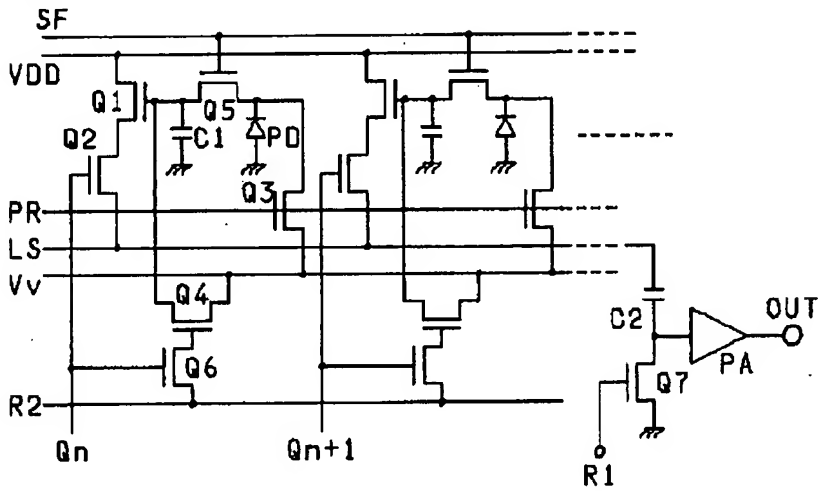


CONSTITUTION: The signal charge of a photodiode PD is transmitted to a capacitor C1 via a switching element Q5 for sensitivity setting, and the holding voltage of the capacitor is taken out via a source follower amplifier element Q1 and a switching element Q2 for selection, and plural photodiodes and picture element cells in which switching elements Q3, Q4 for resetting of capacitor are provided are arranged in line shape, and the photodiodes are reset prior to a timing signal for sensitivity setting, and also, a picture element signal in accordance with a photoelectric conversion signal is outputted via a switching element for readout selection after an output capacitor is reset at a sequentially generated first timing in time series fashion, and the capacitor is reset via a switching element for reset at a second timing, then, a picture element signal setting reset potential as reference can be obtained via the output capacitor.

DRAWINGS

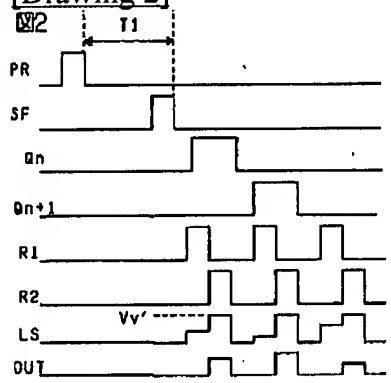
[Drawing 1]

図1

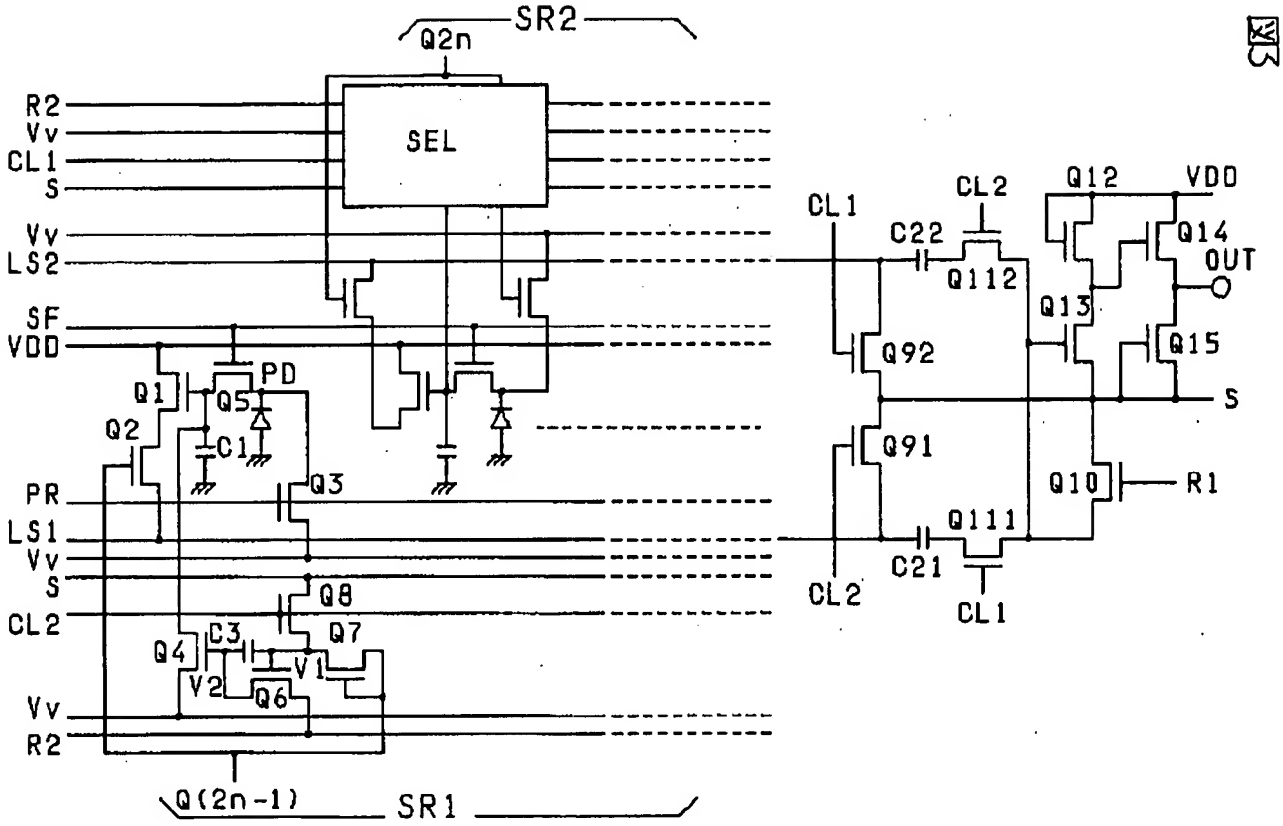


[Drawing 2]

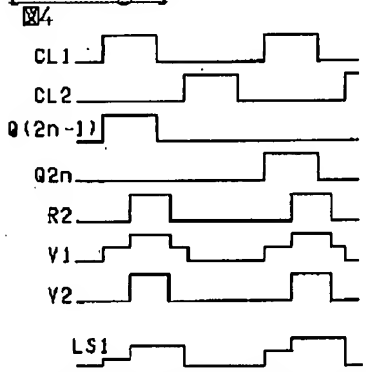
図2



[Drawing 3]



[Drawing 4]



DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] About a solid state image sensor, actuation by the low battery is possible for this invention, and it is used for the line sensor which gave electronic shutter ability, and relates to an effective technique.

[0002]

[Description of the Prior Art] solid-state image-pickup-device" Chapter 7 as the example of a CCD mold line sensor -- the volume on television society -- " -- there is page 216 grade. moreover -- as what replies to the high sensitivity of a solid state image sensor, and the demand of a high SN ratio -- for example, the collection of television society

national conference drafts in 1986 -- there are some which read directly the photo-electric-conversion signal formed with the photodiode outside with source FOROWA amplifier as reported by PP.51-52.

[0003]

[Problem(s) to be Solved by the Invention] Since a CCD mold line sensor drives a CCD component, it needs comparatively high operating voltage, and while power consumption increases comparatively, the configuration of a circumference circuit will become complicated. Moreover, if it is in a handicap type bar code reader, since outdoor daylight changes with service conditions a lot, it is convenient if there is electronic shutter ability in which electric automatic setting of sensibility is possible. Then, in the invention-in-this-application person, the solid state image sensor which gave low-power-izing and electronic shutter ability was examined, attaining high sensitivity-ization using the above-mentioned source FOROWA amplifier.

[0004] The purpose of this invention is to offer the solid state image sensor equipped with electronic shutter ability with the low power. The other purposes and the new description will become clear from description and the accompanying drawing of this specification along [said] this invention.

[0005]

[Means for Solving the Problem] It will be as follows if the outline of a typical thing is briefly explained among invention indicated in this application. Namely, it tells the capacitor changed into a voltage signal through the switching device for a sensibility setup which makes the signal charge by which photo electric conversion was carried out with the perfect depletion-ized photodiode transmit in response to the timing signal for a sensibility setup. Read the maintenance electrical potential difference of this capacitor with a source follower amplifier, and it takes out through the switching device for selection. Two or more pixel cels which prepared the switching device for reset which gives reset potential to the above-mentioned photodiode and a capacitor, respectively are arranged in the shape of Rhine. While forming the output capacitor with which one electrode was combined with the output line through the switch for the above-mentioned selection, preceding with the timing signal for a sensibility setup and giving a reset electrical potential difference to a photodiode by the above-mentioned switching device for reset Read, after making the above-mentioned output capacitor reset in the 1st serial timing by which sequential generating is carried out, and the pixel signal corresponding to a photo-electric-conversion signal is made to output through the switching device for selection. In the 2nd timing, a reset electrical potential difference is succeedingly given to a capacitor through the switching device for reset, and the pixel signal on the basis of reset potential is acquired through the above-mentioned output capacitor.

[0006]

[Function] Since it is what performs sensibility adjustable actuation and read-out actuation by control of a switching device, while according to the above-mentioned means actuation by the low battery is attained and low-power-ization is attained Magnification actuation of a signal charge can be made to perform according to the capacity factor of the capacitor and output capacitor which change the signal charge of a photodiode into a voltage signal. And since it is what reads on the basis of a reset electrical potential difference, and acquires a signal, the bad influence of the variation in the component property in a selection path is not received.

[0007]
[Example] The outline circuit diagram of one example of the line sensor concerning this invention is shown in drawing 1 . In this drawing, the pixel cel, its selection circuitry, and signal readout circuitry for 2 pixels are shown in instantiation as a representative. Each circuit element which constitutes the above-mentioned line sensor is formed on one semiconductor substrate of the manufacturing technology of a well-known semiconductor integrated circuit.
[0008] The photodiode PD with which, as for one pixel cel, the anode lateral electrode was combined with the touch-down potential of a circuit Switch MOSFET(it is the same insulated gate field effect transistor and the following) Q5 for a sensibility setup told to the capacitor C1 which transforms into a voltage signal the photo-electric-conversion charge formed by the photodiode PD, The capacitor C1 which changes into a voltage signal the signal charge transmitted through the above-mentioned switch MOSFETQ5, The magnification MOSFETQ1 to which the maintenance electrical potential difference of this capacitor C1 was supplied to the gate, The cathode lateral electrode of the above-mentioned photodiode PD, and the switches MOSFETQ3 and Q4 which supply the reset electrical potential difference Vv to a capacitor C1, respectively, It consists of switches MOSFETQ6 which were formed in the source side of the above-mentioned magnification MOSFETQ1 and which read and supply a reset signal R2 to the gate of the switch MOSFETQ2 for selection, and a switch MOSFETQ4.
[0009] Let Photodiode PD be the perfect depletion-ized photodiode which is used for a CCD solid state image sensor. Namely, N+ formed in the well field and front face of P type While forming a photodiode by the PN junction constituted by the mold semiconductor region, it is above-mentioned N+. It is P+ to the front face of a mold semiconductor region. A mold semiconductor region is formed. And N+ which constitutes the electrode by the side of the cathode of the above-mentioned photodiode PD By supplying the reset electrical potential difference Vv to a mold semiconductor region, they are the well field of P type, and N+. A mold semiconductor region is depletion-ized.
[0010] The output signal Qn of the shift register for read-out is supplied to the gate of the switch MOSFETQ6 which reads with the gate of the above-mentioned switch MOSFETQ2 for read-out, and tells a reset signal R2 to the gate of reset MOSFETQ4 in common. The low supply voltage [like 5V] VDD whose drain of the above-mentioned magnification MOSFETQ1 is is supplied. Timing signal SF for a sensibility setup is supplied to the gate of the switch MOSFETQ5 for a sensibility setup. Moreover, reset-signal PR are supplied to the gate of the reset MOSFETQ3 which gives the reset electrical potential difference Vv to Photodiode PD. In this drawing, other pixel cels shown in instantiation as a representative are made the same configuration as the above.
[0011] One electrode of the output capacitor C2 is connected to the output line LS to which the switch MOSFET for the above-mentioned read-out is connected in common. Touch-down potential is given to the electrode of another side of this capacitor C2 through a switch MOSFETQ7. The reset signal R1 for read-out is supplied to the gate of this switch MOSFETQ7. And an output signal is acquired from the electrode of another side of the above-mentioned capacitor C2, and the pixel signal amplified through pre amplifier PA is sent out from the external terminal OUT.
[0012] An example of read-out actuation of line SANSA of above-mentioned drawing 1

is explained with reference to the timing chart having shown in Fig. 2. If the reset pulse PR of a photodiode is made high-level, a switch MOSFETQ3 will be made into an ON state, and Photodiode PD will be reset by the reset electrical potential differences Vv all at once. If timing signal SF for a transfer is generated after that, since MOSFETQ5 for a transfer will be turned on, the signal charge formed with Photodiode PD is transmitted to the capacitor C1 changed into a voltage signal. So, the time difference T1 of the above-mentioned reset pulse PR and timing signal SF for a transfer is made into the storage time of Photodiode PD, and sensibility as a line sensor is proportionally made high-like at this time difference.

[0013] If an output signal Qn is made high-level by the shift action of the shift register for read-out, synchronizing with it, the output reset signal R1 will be made high-level by it. The switch MOSFETQ7 is made into the ON state according to the high level of this output reset signal R1.

[0014] In the above-mentioned capacitor C1, the signal charge corresponding to the above-mentioned photo-electric-conversion charge was held, and the voltage signal corresponding to it is generated in it. So, if it reads according to the high level of the above-mentioned output signal Qn and the switch MOSFETQ2 of business is made into an ON state, charge-up actuation corresponding to the signal level held at the capacitor C1 will be performed to a capacitor C2 through magnification MOSFETQ1 and this switch MOSFETQ2. According to read-out actuation of such a signal, corresponding to the gate of magnification MOSFETQ1, and the threshold electrical potential difference between the sources, the level shift of the potential of an output line LS was carried out, it is read from the maintenance electrical potential difference of the above-mentioned capacitor C1, and serves as an electrical potential difference, and it is held at a capacitor C2.

[0015] If the above-mentioned reset signal R1 changes from high level to a low level and a switch MOSFETQ5 is made into an OFF state, the RISSETO signal R2 will become high-level, and a reset signal R2 will be told to the gate of MOSFETQ4 for reset through the switch MOSFETQ6 made into the ON state by the output signal Qn of a shift register. Thereby, it will be in an ON state, and MOSFETQ4 for reset will supply the reset electrical potential difference Vv to a capacitor C1 and the gate which is magnification MOSFETQ1, if it puts in another way.

[0016] Since the switch MOSFETQ2 for read-out is maintaining the ON state at this time, output signal Vv' corresponding to the above-mentioned reset electrical potential difference Vv is outputted to an output line LS through magnification MOSFETQ1. That is, potential Vv' of an output line LS becomes the electrical potential difference by which the level shift was carried out corresponding to the threshold electrical potential difference of magnification MOSFETQ1 from the above-mentioned reset electrical potential difference Vv, it was based on the reset electrical potential difference Vv, and reads, and a signal is acquired from the electrode of the other end of a capacitor C2. The picture signal of the high quality which is not influenced of the process variation since it reads and the threshold electrical potential difference of magnification MOSFETQ1 is offset by the signal by the ejection of the difference component in a capacitor C2 on the basis of such a reset electrical potential difference Vv can be acquired from an output terminal OUT through pre amplifier PA.

[0017] If output-signal Qn+1 of the shift register of the next step is made high-level to the

following timing, the same read-out signal will be acquired from the photodiode of the next step. Thus, it can respond and read to the photo-electric-conversion charge of the photodiode arranged on Rhine, and a signal can be made to output serially corresponding to the shift action of a shift register.

[0018] With the above-mentioned configuration, a signal charge is amplified corresponding to the capacity factor of a capacitor C1 and a capacitor C2. While making the above-mentioned capacitor C1 into small size as much as possible, a magnification operation of a signal charge can be given by the internal circuitry of a line sensor by forming the capacity value of a capacitor C2 comparatively greatly. And since it is based on the above-mentioned reset electrical potential difference Vv, an output signal can be made to also offset the process variation of magnification MOSFETQ1 or a switch MOSFETQ2 as mentioned above.

[0019] In addition, what is necessary is to communalize for example, the above-mentioned shift register SR, and just to prepare 3 sets of above pixel cels and readout circuitries corresponding to three primary colors, in constituting a color line sensor.

[0020] The important section circuit diagram of other one example of the line sensor concerning.this invention is shown in drawing 3 . In this example, since the area which that readout circuitry and reset.circuit occupy is large compared with a photodiode, to a photodiode train, a readout circuitry, a reset circuit, and a shift register are divided up and down, and are arranged. Thereby, a photodiode can be formed on a semi-conductor substrate by high density.

[0021] MOSFETQ4 for reset which makes a capacitor C1 reset is made to carry out switch control in this example by the next circuit. A reset signal R2 is supplied to the gate of MOSFETQ4 for reset through MOSFETQ6 by which switch control is carried out with the output signal Q of the shift register SR 1 of the bottom supplied through MOSFETQ7 of a diode gestalt (2n-1). So, only the reset signal by which the level fall of the gate voltage of MOSFETQ4 was carried out by the threshold electrical potential difference of MOSFETQ7 and the threshold electrical potential difference of MOSFETQ6 from the high level of the output signal Q of the above-mentioned shift register (2n-1) is supplied. Then, a gate [of MOSFETQ6], and source side, if it puts in another way, the bootstrap capacity C3 will be formed between the gates of a switch MOSFETQ4. Between the gate of the above MOSFETQ6, and the grounding conductor S of a circuit, the switch MOSFETQ8 switch control is carried out [the switch] by the clock pulse CL 2 is formed.

[0022] From the upper shift register SR 2, even level output signal Q2n is formed. The shift registers SR1 and SR2 which it comes to divide up and down perform a shift action by clock pulses CL1 and CL2. The output signal Q of the above-mentioned odd level (2n-1) is outputted synchronizing with a clock pulse CL 1, and output signal Q2n of even level is outputted synchronizing with a clock pulse CL 2. The same circuit SEL as the above which forms control signals, such as the switch MOSFET for the above-mentioned read-out and MOSFET for reset, by output signal Q2n, and above reset signals R2 and clock pulses CL 1 of even level is formed. The above-mentioned circuit SEL is shown as a black box by this drawing.

[0023] According to division of the upper and lower sides of the above readout circuitries, as for an output circuit, two output capacitors C21 and C22 are formed. In this example, a switch 91 and MOSFETQ 92 is formed also in the output line LS [LS1 and]

2 side of capacitors C21 and C22. A clock pulse CL 2 is supplied to the gate of the switch MOSFETQ91 corresponding to the output line LS 1 of the photodiode of an odd number train with which an output signal is outputted synchronizing with a clock pulse CL 1. The electrode of another side of a capacitor C21 is connected with the input terminal of pre amplifier at MOSFETQ10 for reset through the switch MOSFETQ111 in which switch control is carried out by the clock pulse CL 1. A reset signal R1 is supplied to this MOSFETQ10 for reset.

[0024] A clock pulse CL 1 is supplied to the gate of the switch MOSFETQ92 corresponding to the output line LS 2 of the photodiode of an even number train with which an output signal is outputted synchronizing with a clock pulse CL 2. The electrode of another side of a capacitor C22 is connected with the input terminal of pre amplifier at MOSFETQ10 for reset through the switch MOSFETQ112 in which switch control is carried out by the clock pulse CL 2. By the switching operation of MOSFETQ91, Q92, and Q111 and Q112 in which switch control is carried out by such clock pulses CL1 and CL2, the output signal of the photodiode PD of an odd number train and an even number train can be taken out through capacitors C21 and C22 by turns.

[0025] Pre amplifier consists of inversed amplification which consists of magnification MOSFETQ13 and a load MOSFETQ12, a source follower output MOSFETQ14 which receives the output signal of this inversed amplification, and a load MOSFETQ15 prepared in that source side. Although not restricted especially, a load MOSFETQ15 consists of depletion type MOSFETs by which the gate and source were communalized.

[0026] The timing chart for explaining an example of actuation of the above-mentioned line sensor is shown in drawing 4 . In this drawing, although omitted, like the timing chart of drawing 2 , a reset pulse PR precedes with the transfer pulse SF, and is generated, and the photo-electric-conversion charge corresponding to the time difference T1 is transmitted to the capacitor C1 grade, respectively. In this condition, when a clock pulse CL 1 is high-level, synchronizing with it, the output signal Q of the shift register SR 1 of odd level (2n-1) is made high-level. By the output signal Q of this shift register SR 1 (2n-1), the switch MOSFETQ2 for read-out is made into an ON state. Moreover, MOSFETQ6 will be in an ON state through MOSFETQ7 of a diode gestalt, and precharge actuation is performed to a capacitor C3. The signal level currently held at the capacitor C1 is outputted to an output line LS 1 through magnification MOSFETQ1 and a switch MOSFETQ2 by the ON state of the switch MOSFETQ2 for the above-mentioned read-out.

[0027] If it puts in another way in advance of the high level of the above clock pulses CL 1, with the high level of the clock pulse CL 2 at the time of read-out actuation of the photodiode of the even number train in front of one, the switch MOSFETQ91 would be in the ON state, and will have reset the line LS 1 for an output to the touch-down potential of a circuit. Moreover, the gate potential V1 of MOSFETQ6 is reset to the touch-down potential of a circuit by the ON state of a switch MOSFETQ8. and the change to the high level of the output signal Q of the above odd level (2n-1) -- synchronizing -- a switch MOSFETQ111 -- ON state **** -- since MOSFETQ10 is a thing and a reset pulse R1 is an ON state more high-level, the output signal corresponding to the signal read to the output line number LS 1 is held at a capacitor C21. Moreover, the gate voltage V1 of a switch MOSFETQ6 has high level to which the threshold electrical-potential-difference part level shift of MOSFETQ7 of a diode gestalt was carried out with

the high level of an output signal Q (2n-1).
[0028] If a reset signal R2 is made high-level, potential of the gate voltage V2 of MOSFETQ4 will be made high by the bootstrap operation by the capacitor C3. So, the reset electrical potential difference Vv is supplied through a switch MOSFETQ4 that there is no level loss in a capacitor C1. Consequently, the potential of an output line LS 1 is changed to the output voltage on the basis of the above-mentioned reset electrical potential difference Vv.
[0029] At this time, the output reset signal R1 is made into a low level, and the switch MOSFETQ10 is made into the OFF state according to this. Therefore, it changes the output side of a capacitor C21 into the flow TENIGU condition, and the output signal corresponding to the signal charge which made the process variation of the read-out path of the above MOSFETQ1 and Q2 and the process variation of a reset path offset is outputted to the gate of magnification MOSFETQ13.
[0030] Such at the time of read-out actuation of an odd number train, according to the high level of a clock pulse CL 1, the switch MOSFETQ92 is an ON state, then it prepares for read-out actuation, and the reset action of the output line LS 2 corresponding to an even number train and a capacitor C22 is performed.
[0031] if a clock pulse CL 2 is made high-level -- it -- synchronizing -- the output signal Q of the shift register SR 2 of even level -- 2n is made high-level. Read-out actuation of the photodiode of an odd number train is started like the above by output signal Q2n of this shift register SR 2, and the read-out signal in the 1st step is acquired at an output line SL 2. This signal is held by the switches MOSFETQ112 and MOSFETQ10 made into the ON state at a capacitor C22.
[0032] Then, although it is omitted in this drawing if a reset signal R2 is made high-level, an output line LS 2 is changed to the output voltage on the basis of the reset electrical potential difference Vv like the above. At this time, the output reset signal R1 is made into a low level, and the above-mentioned switch MOSFETQ10 is made into the OFF state according to this. Therefore, it changes the output side of a capacitor C22 into the flow TENIGU condition, and the output signal corresponding to the signal charge which made a part for the magnification MOSFET corresponding to the photodiode of the above-mentioned even number train, the switch MOSFET for read-out, and the MOSFET process variation for reset offset is outputted to the gate of magnification MOSFETQ13.
[0033] The operation effectiveness acquired from the above-mentioned example is as follows. Namely, (1) It transmits to the capacitor which changes into a voltage signal the signal charge by which photo electric conversion was carried out through the switch MOSFET which constitutes the transfer gate with a perfect depletion-ized photodiode. the maintenance electrical potential difference of this capacitor is read with a source follower amplifier, and it is made to output to an output line through the switching device for selection -- both The switching device for reset which gives reset potential to the above-mentioned photodiode and a capacitor, respectively is prepared. Arrange two or more such pixel cels in the shape of Rhine, and the output capacitor with which one electrode was combined with the above-mentioned output line is formed. While preceding with the timing signal for a sensibility setup and giving a reset electrical potential difference to a photodiode by the above-mentioned switching device for reset Read, after making the above-mentioned output capacitor reset in the 1st timing serially one by one, and the pixel signal corresponding to a photo-electric-conversion signal is

made to output through the switching device for selection. In the 2nd timing, a reset electrical potential difference is succeedingly given to the photodiode concerned through the switching device for reset, and the pixel signal on the basis of reset potential is acquired through the above-mentioned output capacitor. With this configuration, since it is what performs electronic shutter actuation and read-out actuation by control of a switching device like MOSFET, the effectiveness that actuation by single low battery like abbreviation 5V is attained, and low-power-ization is attained is acquired.

[0034] (2) Since it is what can be made to perform magnification actuation of a signal charge according to the capacity factor of the capacitor and output capacitor which change the signal charge of a photodiode into a voltage signal, moreover reads on the basis of a reset electrical potential difference by the above (1), and acquires a signal, the effectiveness that do not receive the bad influence of the variation in the component property in a selection path, and it is made is acquired.

[0035] (3) By distributing a shift register and a read-out system circuit, and a reset system circuit up and down, and dividing them to a photodiode train, the effectiveness that a photodiode can be mounted in high density is acquired.

[0036] Although invention made by this invention person above was concretely explained based on the example, it cannot be overemphasized that it can change variously in the range which this invention is not limited to the above-mentioned example, and does not deviate from the summary. For example, in the example circuit of Fig. 1, it is good also as a CMOS configuration which sets MOSFET for reset to P channel MOSFET, and sets magnification MOSFET to N-channel MOS FET. In this case, when reset-signal PR and R2 are made to reset by making it a low level like the touch-down potential of a circuit, the reset electrical potential difference Vv given to Photodiode PD and a capacitor C1 can be told as it is. That is, the level fall by the threshold electrical potential difference can be prevented like [at the time of using N channel mold MOSFET as an MOSFET for reset] by making operating voltage into the above CMOS structures, when low-battery-ization like about 3 V is attained and supply voltage VDD and the reset electrical potential difference Vv turn into the same electrical potential difference.

[0037] By establishing a bootstrap circuit in the output of shift registers SR1 and SR2, or making the operating voltage itself into the electrical potential difference by which the pressure up was carried out, even if it uses the reset MOSFET of N channel mold, level loss of the reset electrical potential difference Vv can be prevented as mentioned above. An area sensor can also be constituted by establishing a photodiode train two or more lines. In this case, what is necessary is to establish the circuit for train selection in the output side of the above output capacitors, and just to input into the input terminal of pre amplifier.

[0038] With a comparatively low electrical potential difference like 5V, since it was able to operate, the solid state image sensor concerning this invention should fit the handicap type bar code reader etc. Since it is the thing which makes the signal charge of ** transmit to a capacitor to the same timing especially, actuation which reads a bar code accidentally by a hand deflection etc. can be prevented. If it is in the solid state image sensor carried in equipment above handicap type, it is convenient to use a cell as a power source, and it can lengthen the number and battery life of a cell by low-battery-ization of the operating voltage.

[0039] The solid state image sensor concerning this invention can be widely used for

various kinds of image pick-up equipments as others, a line sensor, or an area sensor above handicap type. [bar code reader]

[0040]

[Effect of the Invention] It will be as follows if the effectiveness acquired by the typical thing among invention indicated in this application is explained briefly. Namely, it transmits to the capacitor which changes into a voltage signal the signal charge by which photo electric conversion was carried out through the switch MOSFET which constitutes the transfer gate with a perfect depletion-ized photodiode. the maintenance electrical potential difference of this capacitor is read with a source follower amplifier, and it is made to output to an output line through the switching device for selection -- both The switching device for reset which gives reset potential to the above-mentioned photodiode and a capacitor, respectively is prepared. Arrange two or more such pixel cels in the shape of Rhine, and the output capacitor with which one electrode was combined with the above-mentioned output line is formed. While preceding with the timing signal for a sensibility setup and giving a reset electrical potential difference to a photodiode by the above-mentioned switching device for reset Read, after making the above-mentioned output capacitor reset in the 1st timing serially one by one, and the pixel signal corresponding to a photo-electric-conversion signal is made to output through the switching device for selection. In the 2nd timing, a reset electrical potential difference is succeedingly given to the photodiode concerned through the switching device for reset, and the pixel signal on the basis of reset potential is acquired through the above-mentioned output capacitor. With this configuration, since it is what performs electronic shutter actuation and read-out actuation by control of a switching device like MOSFET, actuation by single low battery like abbreviation 5V is attained, and low-power-ization is attained.